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THESIS

EVALUATION OF THE YOKOSUKA BASE FOR THE U.S. NAVY PACIFIC FLEET OPERATION

by

Hideyuki Haruki

September, 1997

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EVALUATION OF THE YOKOSUKA BASE FOR THE U.S. NAVY PACIFIC FLEET OPERATION

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ABSTRACT

This research concerns evaluation of the Yokosuka base for the U.S.Navy Pacific Fleet operation. The research will focus on fleet operating costs and required fleet assets for a given level of operation. In particular, I will examine what value in terms of fleet operating costs and assets does the United States receive using the Yokosuka base to deploy its fleet in Asia. A computer model will be developed to evaluate this benefit and will compare the differences in operating costs and required fleet assets between the Yokosuka base and other bases such as Guam and Hawaii.

TABLE OF CONTENTS

I. INTRODUCTION

A. BACKGROUND

The United States Navy has maintained a forward deployed aircraft carrier with escorts in the Western Region of the Pacific Ocean since the 1970's. The aircraft carrier and her escort ships operate out of Yokosuka Japan. They are stationed in Yokosuka and play an important role in Asian Security. After the U.S. Navy withdrew from Subic Bay in 1993, the importance of Yokosuka as an operating base significantly increased. The location of Yokosuka as a USN home port is the cornerstone of U.S. strategy in the East Asia Region.

In the near future, Yokosuka Naval Base faces two potential critical problems. One is a budgetary issue. At this time, the Japanese government supports U.S. military bases in Japan and has paid maintenance expenses of about two billion dollars per year since 1989. This support program is temporary and will be reviewed in 2002. It is expected that the Japanese government discontinues this support in the future. The second issue is the replacement of the current aircraft carrier. USS INDEPENDENCE, a conventional powered aircraft carrier, has been stationed in Yokosuka since 1985. She was commissioned in 1958 and is more than 40 years old. Her replacement will probably be a nuclear powered aircraft carrier since the U.S. Navy has not built a conventional

powered aircraft carrier for over thirty years and plans to decommission the older carriers. The Japanese people are very sensitive to nuclear weapons or nuclear powered ships, and the Japanese government has very strict policies for nuclear ship visits to Japan. Because of strong public opinion against nuclear power, it is likely that homeporting of a nuclear aircraft carrier will be denied.

These two issues present large obstacles to a smooth continuous operating base at Yokosuka during the next few years. In view of these issues, it is critical to assess the benefits of operating this base.

B. OBJECTIVES

The purpose of this thesis is to investigate how to evaluate the U.S. Navy Base at Yokosuka and to develop a model which determines its monetary value. It is obvious that the Yokosuka Naval Base is in a vital location for U.S. Asian strategy. But little research has been done to evaluate its importance. One factor that hampers such efforts is the proper formulation of future scenarios in which values are examined. For example, the value of Yokosuka increases significantly at the time of an emergency which calls for quick and sustained operation in that area. This study will not address specific emergency situations, but will rather evaluate the relative value of Yokosuka as a function of the length of the stay at

the various staging areas in East Asia.

C. SCOPE

The main thrust of this study will be to develop a valuation model for the Yokosuka Naval Base. Subsequently, the research apply this model to alternative homeports to evaluate the differences in the operating costs and required fleet assets between these homeports and Yokosuka. The operating costs are largely affected by the distances from the port to various destinations using different fleet transit speeds. These are the major variables. Other variables considered include the number of operating ships, the types of ships, the duration of ships on station and ship deployment intervals.

D. RESEARCH QUESTIONS

Primary research question: What are the major benefits of operating a homeport at Yokosuka for the U.S. Pacific Fleet? The benefits are measured in terms of reduced operating costs and smaller required assets to stage given operations in Asia.

To answer the primary question, the study will address the following secondary research issues:

1. Compare fleet operating costs between Yokosuka, Guam, and Hawaii for a given level of operation.

2. Compare the level of operation between homeports for a given level of budget.

3. Compute cost-minimizing transit speed for the fleet.

4. Compute a new asset requirement when homeport changes.

5. Compute a deployment interval when homeport changes.

E. METHODOLOGY

The methodology required for this research can be divided into the following four steps: (1) establishing the premises: (2) data collection: (3) constructing the model: and (4) interpreting the model results.

1. Premises

It is needed to define the premises for the model for the various scenarios which will be used as a model input.

2. Data

Required data for this model includes fuel consumption rates for each type of ship, the distance between port and deployment areas, and shipbuilding costs. Data will be collected from open publications.

3. Model

I will expressly delineate what variables are applied in this model and what variables are excluded. I will describe what the model is, how it works, and what the model can do.

4. Interpretation

The results of the model calculations will be interpreted. Additionally required variables will be

identified.

F ORGANIZATION

This thesis is divided into four chapters.

Chapter I provides the introduction and purpose for this study. It states the research questions, the objectives to be accomplished, the scope of the analysis, the methodology to be employed, as well as the organization of the thesis.

Chapter II describes the background of the model, basic assumptions of the model, the format of the model and input parameters.

Chapter III explains results of the model.

Chapter IV discusses a summary of the thesis and conclusions.

II. THE FLEET OPERATION COST MODEL

A. BACKGROUND OF THE MODEL

The purpose of this model is to evaluate the differences in fleet operating costs and required fleet assets between the Yokosuka homeport and other homeports such as Guam and Hawaii. The model examines the fleet operation cost from Yokosuka to designated areas such as Korea, the Taiwan Strait and the Philippine Sea, Singapore, and Japan itself. The model determines the operating costs from Hawaii and Guam to various destinations. Then, the model calculates the differences in the operating costs between Yokosuka and other homeports. The model also looks at the required assets for these operations. Then, it calculates the monetary value based on various ships assets, and displays the cost for groups of assets.

Ship operating costs consists of fuel costs, maintenance costs, personal and food expenses. However, in this thesis the ship operating costs are based solely on fuel utilization, since fuel is the dominant factor. It is not necessary to include personal and food expenses, because these costs are incurred whether the ship operates or not. The difference in maintenance costs are difficult to determine, because ship maintenance is not clearly related to operating time alone. Only fuel costs can be differentiated with some degree of

accuracy by transit distance.

The model user enters what type of ship and how many ships are needed and how long they should stay in a specifically designated area as the output goal. Then the model computes the total required assets for each class of ship to achieve such output goal. The number of ships required depends on the transit distance, transit speed and on the length of a stay at the staging area. The model compares the required number of ships for the various homeports and destinations. Also, the model calculates the acquisition cost for those assets.

Appendix A is the display of the input and output pages of the model. This model is constructed using a Lotus 1-2-3 spreadsheet program. Variables are deployment area, homeports, transit speed, deployment interval and fleet composition(the type of ship and the numbers of each type of ship).

B. THE PREMISES OF THE MODEL

It is important to define what sorts of premises work for this model. There are many variables used to evaluate and forecast the fleet operation cost in the real world. To translate from the real world to the modeled world, it is necessary to define the variables and the constants. The factors which are defined as constants are premises.

The premises for this model are as follows:

1. Fleet composition remains the same for the period of this study.

2. U.S. Fleet can not replenish itself in Asia with the exception of Yokosuka, Japan.

3. The replenishment ship delivers fuel and food to the staging area every four weeks.

4. Fleet cruise speed is six knots at the staging area.

5. The real fuel price remains constant.

6. This model does not consider nuclear powered ships.

7. The maintenance costs and maintenance intervals are assumed to remain the same for the various homeport scenarios.

8. The ships require preparation time for cruises which are calculated as one half of the prospective operation time at sea.

C. FORMAT OF THE MODEL

The model, as seen in the Lotus 1-2-3 spreadsheet, consists of seven pages. The first page is the input and output part. The user can input the desired variables on the first page. Based on these inputs, the model computes the operating costs of each type of ship and the number of ships of the type required and displays them in the following six pages. An output summary of the required assets and operation costs are reported in the first page. The outline of each Lotus 1-2-3 spreadsheet is provided below:

page 1	Input variables (Columns A through C) Output summary (Columns E through H) Data display (Columns J through O)

The details of page one are shown in Appendix B.

page 2	associated cost of CV (Appendix C)
page 3	associated cost of CG (Appendix D)
page 4	associated cost of DDG (Appendix E)
page 5	associated cost of DD (Appendix F)
page 6	associated cost of FFG (Appendix G)
page 7	associated cost of AOE (Appendix H)

III. INTERPRETATION OF THE RESULTS

In this section, I will show the usages of this model and the interpretation of the results.

A. THE DIFFERENCE OF THE OPERATION COST AND THE COST OF THE NEEDED ASSETS

The user can find the difference of the operation costs based on the various homeports and the cost of the needed assets by selecting the variables, which are destination, homeport, transit speed, staging duration, deployment interval and type and number of ships.

For example, when the U.S. Navy needs to deploy the 7th fleet to the Korean Peninsula for 12 weeks, the model can show the difference of the operation cost between ships deploying from Hawaii and Yokosuka. It can also give the number of ships required for each ship type selected by the user. In this case, the user can select or input the variables on page one of the model. The user can select and input the destination to Korea, homeport A for Hawaii, homeport B for Yokosuka, transit speed from both homeports to be 18(knots), staging duration as 12(weeks), a deployment interval of eight (weeks) and the fleet composition of (CV:1, CG:2, DD:3, FFG:4 and AOE:1).

In this example, the operation cost from Hawaii is 30.2 million dollars and from Yokosuka is 15.9 million dollars. The

difference of the operation cost is 14.3 million dollars. The deployment from Yokosuka is 14.3 million dollars less than a deployment from Hawaii. The differences for needed assets between Hawaii and Yokosuka are one CV, two CGs, three DDs, four FFGs and one AOE. These additional assets cost around 6.5 billion dollars.

Table one shows differences in the operational costs for alternative homeports and other destinations when compared to Yokosuka.

Table 1 THE DIFFERENCE OF THE OPERATIONAL COST*
(BASE LINE FROM YOKOSUKA)

	(DESTINATION)			
	Korea	Taiwan	Philippine	Singapore
Scenario ** from Hawaii	**14.3**	14.4	14.4	15.2
Scenario from Guam	2.1	0.9	-0.04	-0.8

(Million dollars)

* Other assumptions are remaining 12 weeks in staging area and a deployment interval of eight weeks.
** For this scenario, additional ship assets must be acquired. This includes one CV, two CGs, three DDs, four FFGs, and one AOE.

These results indicate that a change in homeport to Hawaii will not significantly increase operation cost, if the ship assets are allowed to increase. However, if the change of homeports is to Guam, then the operation cost hardly changes.

In this model, the distances from homeport to a

destination are a major factor. Distances are shown in Table 2.

Table 2 Distance Table (miles)					
	Korea	Taiwan	Philippine	Japan	Singapore
Hawaii	4,385	4,595	4,869	3,397	5,881
Guam	1,837	1,669	1,742	1,357	2,585
Yokosuka	1,070	1,335	1,758	0	2,889

1. Change in Staging Duration

By using this model, it is possible to evaluate the difference in operation costs as a function of the staging duration.

For example, consider Korea as the destination, and Hawaii as the alternative homeport. We assume the same transit speed of 18 knots and a deployment interval of eight weeks, and the fleet composition of(CV:1, CG:2, DD:3, FFG:4 and AOE:1).

The effect of changes in staging duration in the operation costs is shown in Figure 1.

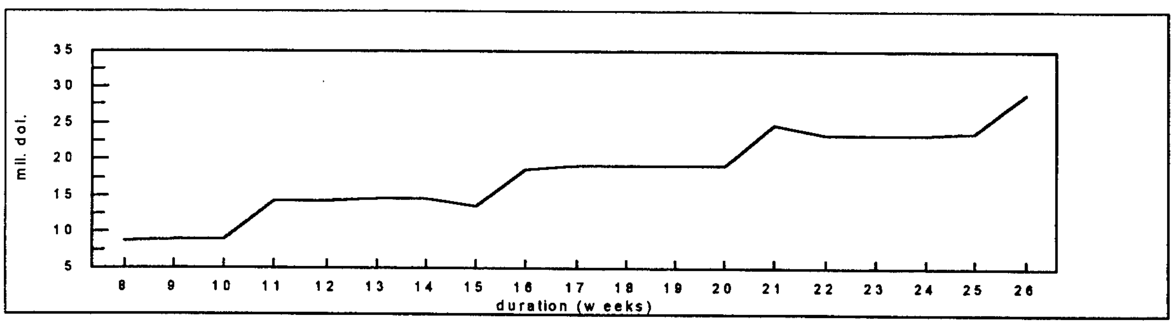

Figure 1 The Differnce in Operation Cost*

* Ships assets level for Hawaii remains the same as in Yokosuka for a duration up to 10 weeks. For durations longer than 10 weeks, additional assets must be acquired including one CV, two CGs, three DDs, four FFGs, and one AOE.

Figure 1 indicates that the longer time on station significantly affects operation costs when Hawaii is used as a homeport. However, the difference in operation cost is not a simple increasing function of the staging duration.

For example, the differences of operation costs for durations of 15 weeks and 22 weeks are smaller than that of 14 and 21 weeks respectively. To explain more specifically, the longer duration makes the number of transit times from Yokosuka increase. The increased transits from Yokosuka reduce the difference of the cost when compared with Hawaii. For a duration of 14 weeks, the fleet needs two transits from Yokosuka. For a duration of 15 weeks, the fleet needs three transits.

Table 3 Operation Cost and the Difference(million dollars)

Staging duration(weeks)				
	14	15	21	22
Operation Cost From Hawaii	32.9	34.0	52.0	53.1
Operation Cost From Yokosuka	18.2	20.6	27.3	29.7
The difference	**14.7**	**13.4**	**24.7**	**23.4**

Table 3 shows the operation cost from each homeport and the differences in operation costs.

2. Change in Deployment Interval

Using this model, it is also possible to evaluate the difference in operation costs as a function of the deployment interval. For this example, Korea is chosen as the destination, Hawaii as an alternative homeport. The staging duration of 12 weeks, 18 knot transit speeds, and the fleet composition of(CV:1, CG:2, DD:3, FFG:4 and AOE:1) are used for the computation.

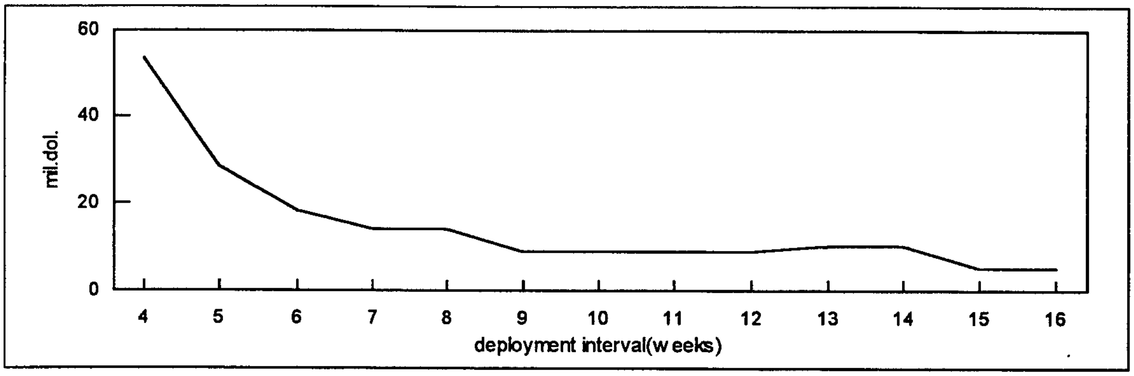

Figure 2 The Difference of Operation Cost

Figure 2 shows that the longer deployment interval reduces the difference in the operation costs between Yokosuka and Hawaii. However, the cost reduction becomes almost negligible after the nine weeks deployment interval point for the 12 weeks staging duration. When the fleet transits from Hawaii to East Asia, the cost penalty becomes significant for a shorter deployment interval, when the deployment interval is less than seven weeks.

B. COMPARISON OF THE LEVEL OF OPERATION BETWEEN HOMEPORTS FOR A GIVEN BUDGET LEVEL

The model allows us to compute the achievable staging duration. For the same amount of operation cost, the fleet can operate for a different duration of time depending on the homeport.

Table 4 THE EXTRA LENGTHS OF STAY FROM YOKOSUKA COMPARED TO HAWAII AND GUAM's 12 WEEKS OPERATION

	(DESTINATION)			
	Korea	Taiwan	Philippine	Singapore
Compare to Hawaii	**8.0**	8.0	7.5	7.9
Compare to Guam	1.8	0.7	0.0	-0.8

(weeks)

Table 4 shows the extra length of time that the fleet could operate at the various staging area from different homeports when compared with Yokosuka. For this comparison, the operation cost is computed based upon 12 weeks of staging duration for both Hawaii and Guam. Other assumptions are 18 knot transit speed, 12 week deployment interval, and the fleet composition of(CV:1, CG:2, DD:3, FFG:4 and AOE:1). For example, if the destination is Korea, then the fleet can stay 8.0 weeks longer than the situation when its homeport is Hawaii.

C. ALTERNATIVE STRATEGY WITHIN EXISTING ASSETS

The cost of needed assets is far greater than operation costs. In current U.S. budget climate, however, it may be unrealistic to assume an increase in the number of ship assets or an increased budget for ship acquisition. The Navy is more likely to be tasked to manage the existing number of ships for the mission. The model allows consideration of alternatives in achieving the mission within the existing number of ships. The variables in this case are deployment interval and transit speeds. If the ships can stay at sea longer, then fewer ships will be needed. Additionally, if the fleet transits at a faster speed, fewer ships will be needed.

1. Required Deployment Interval

It is obvious that if the fleet can stay longer at the designated area, the Navy will need a smaller number of assets. To maintain the fleet at the designated area, the Navy must prepare for a replacement set, if the deployment interval is fixed. One fleet would be on station, while the other is transiting to or preparing to go to sea. If the deployment interval is not long enough, the fleet can only stay a short time at the designated area. Therefore, the Navy needs a larger number of ships in this case.

On the other hand, if the deployment interval is lengthened, then the need for additional ships will be

reduced. However, longer deployment intervals are likely to cause morale problems. This is difficult to quantify in dollar terms, but low morale could manifest itself in increased physical damage or a loss of qualified personnel. It is important, therefore, to look for the deployment interval with this in mind. Since the model does not quantify the added costs of a longer deployment, this optimization will not be taken up in this thesis.

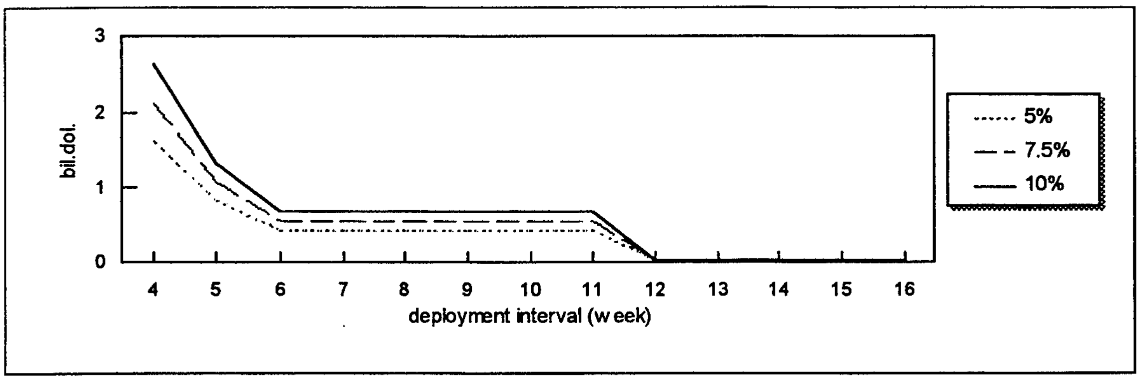

Figure 3 Annualized Capital Cost for 30years Depend on the Interest Rate

Figure 3 shows the annualized capital cost for needed assets for 30 years. If a deployment interval is four weeks, the Navy needs more assets at a cost of 24.9 billion dollars for this operation. The 24.9 billion dollars cost is annualized at 2.64 billion dollars for 30 years with a 10% interest rate, and 2.11 billion dollars with a 7.5 % interest rate. Also, when a deployment interval is eight weeks, the annualized capital cost is 679 million dollars with a 7.5 % interest rate, and 416 million dollars with a 5% interest

rate.

The deployment interval for each destination and homeport was changed, but the other assumptions are the same as the previous example. The model can compute the required deployment intervals when the ship assets remains the same. The results are shown in Table 5.

Table 5 THE REQUIRED DEPLOYMENT INTERVAL TO MINIMIZE ASSETS FROM HAWAII AND GUAM TO VARIOUS DESTINATIONS

	(DESTINATION)			
	Korea	Taiwan	Philippine	Singapore
From Hawaii	12	13	13	16
From Guam	5	3	no optimal	(8)

(weeks)

With no increase in ship assets, the fleet must deploy 12 to 16 weeks to stage an eight week operation when its homeport is Hawaii.

2. Required Transit Speed

It is evident that if the transit speed is faster, the needed assets would be smaller. In this case, the variable is transit speed. For example, the user selects Korea as the destination, Hawaii as an alternative homeport, staging duration as 12(weeks), a deployment interval as eight weeks, and the fleet composition of (CV:1, CG:2, DD:3, FFG:4 and AOE:1).

The results are shown in Figure 4. This figure shows that a transit speed of 27 knots is required to eliminate the need

for additional assets.

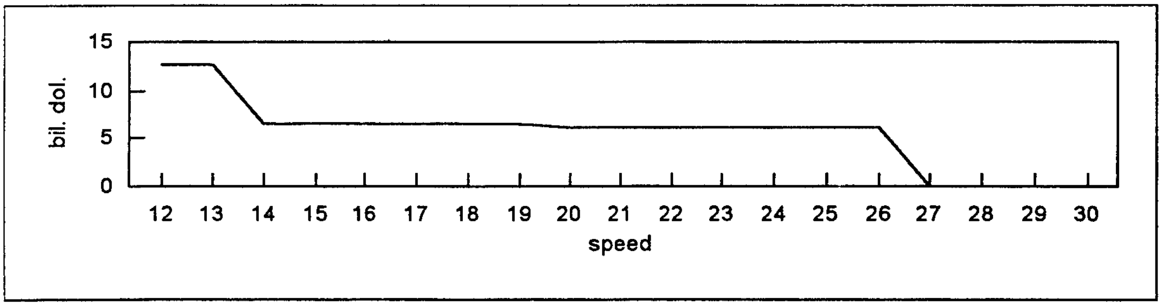

Figure 4 The Difference of Assets Cost

In the model, the transit speeds are changed for each destination and homeport. The other assumptions remain the same as the previous example. The model shows the required transit speeds which eliminate the need for additional assets. The results are shown in Table 6.

Table 6 THE REQUIRED TRANSIT SPEED TO MINIMIZE ASSETS FROM HAWAII AND GUAM

	(DESTINATION) Korea	Taiwan	Philippine	Singapore
From Hawaii	27	28	29	over 30
From Guam	11	10	--	(9)

(knots)

Table 6 shows that the higher transit speed eliminates the difference of the assets cost when compared to ships departing from Yokosuka. When the fleet transits beyond the speeds which are shown in Table 6, there is no difference in the needed assets between Hawaii and Yokosuka except for the Singapore destination. However, continuous high speed and long

distance transits from Hawaii will cause physical damage to the ships, and result in higher maintenance and repair costs. This high speed alternative may not be a realistic option in peace time.

IV. CONCLUSION

The primary research objective of this thesis is to determine the major benefits of operating a homeport in Yokosuka for the U.S. Pacific Fleet.

The following four points summarize the main ideas based on the results of the model calculation:

1. The difference in the operation costs between Hawaii and Yokosuka are not significant when compared with the associated increase in asset costs.

2. When the asset level is fixed, the fleet deployment from Hawaii to Asia increases the deployment intervals over those from Yokosuka. Such increased deployment intervals will likely to have a significant cost impact on its operation.

3. When the fleet transits at a high speed from Hawaii, it can reduce the need for additional assets. However, this option requires further examination, in particular its implication on the expected increase in repair/maintenance costs.

4. Operation costs for the fleet between Guam and Yokosuka are very similar. However, Navy needs a large investment to improve the fleet support capability at Guam.

In conclusion, the fleet operation from Yokosuka results in lower operation costs and a smaller deployment interval,

and fewer ships. The change of homeport to Hawaii requires a larger number of ships or a higher speed of transit to achieve the same level of output. The change of homeport to Guam will have a similar operation and asset cost as Yokosuka. However, the change of homeport to Guam may require an investment in fleet support capability.

APPENDIX A
(INPUT AND OUTPUT PAGE OF THE MODEL)

A B C E F G H

INPUT SECTION

		Korea:1
DESTINATION	1	Taiwan:2
		Philipine:3
		Japan:4
		Sinapore:5
homeport A	1	HAWAII:1
homeport B	3	GUAM:2
		JAPAN:3
Transit sp from A	18	
Transit sp from B	18	
DURATION fm A	12	
DURATION fm B	12	
Deployment Interval (wks	8	
CV	1	
CG	2	
DDG	0	
DD	3	
FFG	4	
AOE	1	

OUTPUT SECTION

	operate fm A	operate fm B	difference
OPERATING COST(mil$)			
CV	$7.145	$3.539	$3.606
CG	$4.987	$2.712	$2.275
DDG	$0.000	$0.000	$0.000
DD	$11.088	$6.423	$4.664
FFG	$5.384	$2.842	$2.541
AOE	$1.630	$0.398	$1.232
TOTAL	$30.233	$15.915	$14.318
ASSET	(number)	(number)	(Cost mil $)
CV	3	2	$1,602.200
CG	6	4	$2,049.800
DDG	0	0	$0.000
DD	9	6	$563.100
FFG	12	8	$1,922.400
AOE	2	1	$324.300
TOTAL			$6,461.800
TOTAL			$6,476.118

J K L M N O

DESTINATION

		KOREAN:1	TAIWAN:2	PHILIPINE:3	YOKOSUKA:4	SINGAPORE:5
HOME	HAWAII:1	4385	4595	4869	3397	5881
PORT	GUAM:2	1837	1669	1742	1357	2585
	YOKOSUKA:3	1070	1335	1758	0	2889

APPENDIX B

(EXPLANATION OF THE INPUT AND OUTPUT PAGE)

Appendix B provides details of the model with an explanation of each cell on page one.

A. INPUT, OUTPUT AND DISTANCE DATA SECTION

Page one of the model contains an input section, an output section and distance data section. In the input section, the user can input the desired variables. In the output section, the results are calculated based on the inputs. For the distance data section, there is a table which shows the distances between bases and destinations. An example of this page is shown in Appendix A.

1. INPUT SECTION

The input section has three columns labeled A, B and C. Column A provides the titles of the input variables. Column B lists the input variables. The user selects the variables which are desired. Column C gives supplemental information on the input variables.

a. DESTINATION

Cell B3 of page one is the destination input cell. The user inputs the destination in cell B3. This destination is important for evaluating the fleet operating cost and fleet asset costs in the model. Cell A3 shows the

title of 'DESTINATION'. The cells from C2 to C6 exhibit the destinations which the operator can select. The user can input a number which corresponds to each destination. In this thesis, Cells C2 through C6 lists the destination as follows: C2 - Korea:1, C3 - Taiwan:2, C4 - Philippines:3, C5 - Japan:4, and C6 - Singapore:5.

b. HOMEPORT

Cells B8 and B9 are the cells where the user inputs the desired bases for the fleet. The user selects two desired homeports from the choices listed in cell C8, C9, and C10. Cell A8 is the title 'homeport A', and cell A9 is the title 'homeport B'. Cells C8 through C10 lists the homeports as follows: Cell C8 - Hawaii:1, C9 - Guam:2, and C10 - Japan:3. Based on these inputs, the difference of the fleet operating cost can be determined. For example, the user can input 1(:Hawaii) for cell B8(homeport A) and 3(:Yokosuka) for cell B9(homeport B). Then the user would be able to know the difference of the operating costs between Hawaii and Yokosuka.

c. TRANSIT SPEED

For cells B12 and B13, the user inputs the desired transit speed from each of the homeports(homeport A and homeport B). Cell A12 shows the title 'Transit sp from

A'. Cell B12 is the transit speed from homeport A. Cell A13 is the title 'Transit sp from B'. Cell B13 is the transit speed from homeport B. The applicable transit speed of this model varies from 6 to 30 knots. The transit speed must be an integer. In this model, each fleet transits at the same speed.

d. STAGING DURATION

Staging duration is important for calculating the fleet operating cost. Cells B15 and B16 are the staging duration input cells. Cell A15 is the title 'DURATION fm A'. Cell B15 is the staging duration the fleet operates from homeport A. Cell A16 is the title of 'DURATION fm B'. Cell B16 lists the staging duration of time in weeks that the fleet operates from homeport B. The model calculates the operating cost for this designated period. For example, if the user wants to have an output for one year, he inputs "52" (weeks).

e. DEPLOYMENT INTERVAL

Cell B18 is deployment interval input cell. Cell A18 is the title 'Deployment interval'. The definition of deployment interval is the length of time that the fleet stays at sea. The fleet is modeled to leave their homeport for the destination area, and return to the same homeport.

The deployment interval is the period from a homeport to the destination and back to the same homeport. This cell shows how many weeks the fleet will remain at sea.

f. FLEET COMPOSITION

Cells B20 to B25 are fleet composition cells. The user can select the desired fleet composition, and input the desired numbers in the cell. Cell B20 is the number of CV's(CV-63/67 class). Cell B21 is the number of CG's(CG-47 class). Cell B22 is the number of DDG's(DDG-51 class). Cell B23 is the number of DD's(DD-963 class). Cell B24 is the number of FFG's(FFG-7 class). Cell B25 is the number of AOE's(AOE-6 class). If you select the same composition as the actual Seventh Fleet, you can get the operating costs for Seventh Fleet.

2. OUTPUT SECTION

The output section is displayed in columns E to H, rows 2-21. Column E lists the title of the output. Column F provides the operating costs and initial plus replacement assets when the fleet operates from homeport A. Column G shows a similar output from homeport B. Column H provides the difference of the operating costs and needed asset costs between the fleets operating from homeport A and homeport B. These outputs are based on the variable

section inputs.

a. OPERATING COST

Cell F4 is the operating cost of CVs from homeport A. Cell G4 is that cost from homeport B. Cell H4 is the difference between the value in cell F4 and G4. The value in cell F4 is derived on page two which calculates the operating cost of CV's from Homeport A. Cell G4 is that similar value from homeport B. The formula for these cells is as follows:

Cell F4 = B:D13

Cell G4 = B:E13

Cell H4 = A:F4-A:G4

Rows five to nine of the output section correspond to each type of ship. Row five pertain to CGs, row six to DDGs, row seven to DDs, row eight to FFGs and row nine to AOEs. The formula for these cells is:

cell F5 = C:D13, cell G5 = C:E13, cell H5=A:F5-A:G5

cell F6 = D:D13, cell G6 = D:E13, cell H6=A:F6-A:G6

cell F7 = E:D13, cell G7 = E:E13, cell H7=A:F7-A:G7

cell F8 = F:D13, cell G8 = F:E13, cell H8=A:F8-A:G8

cell F9 = G:D13, cell G9 = G:E13, cell H9=A:F9-A:G9

Row 10 indicates the total operating costs. Cell F10 is the sum of F4 through F9. This formula is @sum(F4..F9).

Cell G10 is the sum of G4 through G9 and this formula is @sum(G4 to G9). The formula of H10 is @sum(H4 to H9).

b. ASSETS COST

Assets costs are shown in 1997 dollar value by using deflators.

Cell F13 is the number of the needed CV's from homeport A. Cell G13 is the number from homeport B. Cell H13 is the difference between the cells F13 and G13. The value in cell F13 is derived on page two which calculates the needed assets of CV's from Homeport A. Cell G13 is the calculation from homeport B. The formula for these cells is as follows:

Cell F13 = B:D14

Cell G13 = B:E14

Cell H13 = B:F14

Rows 14 to 18 of the output section correspond to each type of ship. Row 14 pertains to CGs, row 15 to DDGs, row 16 to DDs, row 17 to FFGs, and row 18 to AOEs. The formula for these cells is:

cell F14 = C:D14, cell G14 = C:E14, cell H14=C:F14

cell F15 = D:D14, cell G15 = D:E14, cell H15=D:F14

cell F16 = E:D14, cell G16 = E:E14, cell H16=E:F14

cell F17 = F:D14, cell G17 = F:E14, cell H17=F:F14

cell F18 = G:D14, cell G18 = G:E14, cell G18=G:F14

3. DISTANCE DATA SECTION

The distance data table is located in cells J2 through O5. This table shows the distance between destinations and bases. The distances are shown in nautical miles. The data source is PUB.151 FIFTH EDITION, titled "DISTANCES BETWEEN PORTS", and published in 1985 by the Defense Mapping Agency. Destination Korea lists the distance from each homeport to Inchon, Republic of South Korea and destination Taiwan lists the destination from each homeport to Amoy, China. Destination Philippines lists the destination to Manila and destination Yokohama is substituted for Yokosuka.

APPENDIX C
(ASSOCIATED COST OF CV)

Appendix C provides and explanation of each cell on page two.

A. Column A(title section)

Title section is in column A on this page. Cell A2 lists the ship type as a CV of this page. Cell A5 shows the number of CV's which are in the fleet. The number of CV's is transferred from input section of page one. The formula of cell A5 is +A:B20.

B. Column C(Calculation title)

Column C provides the title of each calculation in column D.

Cell C2 is "homeport".

Cell C3 is "speed".

Cell C4 is "distance".

Cell C5 is "transit hour".

Cell C6 is "transit day".

Cell C7 is "fuel consumption rate".

Cell C8 is "fuel consumption for transit".

Cell C9 is "fuel cost for transit".

Cell C10 is "possible on station days".

Cell C11 is "fuel cost on station".

Cell C12 is "transit times".

Cell C13 is "total fuel cost".

Cell C14 is "the number of required assets".

C. Column D(Calculation from base A)

This column display the results of the calculations concerning CV operational costs and needed assets from base A. When the fleet operates from base A, this column shows the results in various stages concerning the time, distance, speed, and the cost to operate the CV or CVs.

Cell D2 shows the code number of base A which is determined by users on page one. The code number of base A is transferred from page one to cell D2 of page two. The formula of cell D2 is +A:B8.

Cell D3 shows the transit speed from base A to the destination. This speed is transferred from page one using formula +A:B12.

Cell D4 shows the distance from base A to the destination. The distance table is located on page one A:J2~O5. The formula for cell D4 is @INDEX(A:J2..A:O5,A:B3,A:B8). A:B3 is the destination, A:B8 is base A. Since the user decides on the destination and base A, this formula picks up the associated distance from the distance table on page one.

Cell D5 calculates the transit hours from base A to the destination. The formula of cell A5 is +D4/D3. The numerator is the distance between the destination and base A. The denominator is the transit speed.

Cell D6 translates the transit hours into days. The formula for cell D6 is +D5/24.

Cell D7 displays the fuel consumption rate of the CV at designated speed. The fuel consumption rate table for a CV is located in cells H2~I27 of page two. The fuel consumption rate is in kilo gallons per hour. The formula for cell D7 is @VLOOKUP(D3,H2..I27,1). By using this formula, this cell calculates the fuel consumption rate associated with the speed.

Cell D8 calculates the fuel consumption for the transit from base A to the destination and back again. The formula for cell D8 is +D5*D7*2. Cell D5 displays the transit hours from base A to the destination. Cell D7 represents fuel consumption per hour. Times two means two way transits.

Cell D9 calculates the two way cost for the transit between base A and the destination. In this model, one kilo gallons of fuel costs 700 dollars. The formula for cell D9 is D8*700.

Cell D10 calculates on station days at the destination. The deployment interval is determined by the user in the input section on page one(A:B17). The amount of on station days is calculated from the deployment interval minus the two way transit days. The formula for cell D10 is +A:B18*7 - D6*2.

Cell D11 calculates the fuel cost on station. On station days come from cell D10. Based on the initial assumptions, the fleet cruises at six knots in the deployment area. The fuel consumption rate of six knots is shown in cell I3. The formula for cell D11 is @IF(D4=0,0,D10*24*I3*700). If the homeport and destination are the same, the distance is zero. In this case, the fuel cost on station would not be needed. If the distance is not zero, the fuel cost on station is on station days times 24 hours times the fuel consumption per hour at six knots times the fuel cost per kilo gallon.

Cell D12 calculates the transit times with the given staging duration, speed, distance and deployment interval. Based on the initial conditions, the fleet will not replenish in Asia. The fleet must go back and forth within the given staging duration. The needed transit times can be obtained by dividing the staging duration by the on station

days. The fleet must remain on station continuously for the designated staging duration. The on station times for each transit is calculated in cell D10. It should be noted that the results are rounded up to the nearest integer. The formula for cell D12 is @INT((A:B15*7/D10)+.9999).

Cell D13 displays the total fuel cost. The two way fuel cost for the transit is located in D9. The fuel cost for on station time is in D11. The transit cost for the given staging duration of each transit is calculated by multiplying the cost in cost D9 by transit times in D12. The formula is D9*D12. The on station cost for the staging duration is calculated by multiplying on station cost per day by total on station days. The formula is D11*A:B15*7/D10. Finally the total staging duration cost sums up the transit cost plus the on station cost and the number of ships denoted in A5. The results in millions of dollars is accomplished by dividing the total by 1,000,000. The formula for D13 is (D9*D12+D11*A:B15*7/D10)*A5/1,000,000. The results in D13 is transferred to cell F4 on page one.

Cell D14 calculates the number of replacement sets for the operation. The ships obviously need preparation time for the next cruise. In accordance with the premise of the

model, the preparation time is one half of the deployment interval. Therefore total times required for each group of ships are the deployment interval plus preparation time. It should be noted that ships must be on station in the designated area, and the possible on station days are calculated in D10. Then the needed ships are calculated by using the sum of the deployment interval plus the preparation time divided by the on station time. The needed assets are rounded up to the nearest integer. The formula for D14 is @IF(D4=0,A5,(@INT((A:B18*7*1.5/D10)+.9999)*A5). The results of D14 are transferred to cell F13 of page one.

D. Column E(Calculation from homeport B)

Column E displays the cost for the fleet to operate from homeport B. The procedure in this column are the same as for column D. The formula for each cell is as follows:

Cell E2: +A:B9

Cell E3: +A:B13

Cell E4: @INDEX(A:J2..A:O5,A:B3,A:B9)

Cell E5: +E4/E3

Cell E6: +E5/24

Cell E7: @VLOOKUP(E3,H2..I27,1)

Cell E8: +E5*E7*2.

Cell E9: +E8*700.

Cell E10: +A:B18*7 - E6*2

Cell E11: +@IF(E4=0,0,E10*24*I3*700)

Cell E12: @INT((A:B16*7/E10)+.9999).

Cell E13: (E9*E12+E11*A:B16*7/E10)*A5/1,000,000.

Cell E14: @IF(E4=0,A5,(@INT((A:B18*7*1.5/E10)+.9999)*A5)

E. Column F(difference between A and B)

Column F provides the difference between homeport A and homeport B for the cost and the number of the needed assets.

Cell F13 provides the difference between homeport A and homeport B for operational costs. The formula for cell F13 is D13-E13.

Cell F14 displays the difference in the number of replacement sets needed with regard to homeport A and homeport B. The formula for cell F14 is +(D14-F14)*1602.2. 1602.2 million dollars represents the replacement value for a CV in 1997.

The unit cost for CV-64 was 275.1 million dollars in 1961. Source : DEPARTMENT OF DEFENSE APPROPRIATIONS FOR 1961 ; PART 5 p 272.

The deflator for military procurement in 1961 was 0.1717. Source : NATIONAL DEFENSE BUDGET ESTIMATES-FY1997 p42(U.S.

Secretary of Defense)

275.1/0.1717=**1,602.2** (million)

The results in cell F14 are transferred to A:H13 on page one.

F. Column H and I(Fuel Consumption Data)

Column H shows the fuel consumption rates for speeds ranging from six knots to 30 knots. The fuel consumption rates and corresponding cells are shown below.

Cell H3:6, Cell I3:2.0117

Cell H4:7, Cell I4:2.0507

Cell H5:8, Cell I5:2.1204

Cell H6:9, Cell I6:2.1901

Cell H7:10, Cell I7:2.2891

Cell H8:11, Cell I8:2.4242

Cell H9:12, Cell I9:2.5593

Cell H10:13, Cell I10:2.7533

Cell H11:14, Cell I11:2.9473

Cell H12:15, Cell I12:3.2156

Cell H13:16, Cell I13:3.4839

Cell H14:17, Cell I14:3.8463

Cell H15:18, Cell I15:4.2087

Cell H16:19, Cell I16:4.6911

Cell H17:20, Cell I17:5.1735

Cell H18:21, Cell I18:5.7669

Cell H19:22, Cell I19:6.4991

Cell H20:23, Cell I20:7.2312

Cell H21:24, Cell I21:8.1980

Cell H22:25, Cell I22:9.1648

Cell H23:26, Cell I23:10.7479

Cell H24:27, Cell I24:10.4478

Cell H25:28, Cell I25:13.4481

Cell H26:29, Cell I26:15.1654

Cell H27:30, Cell I27:17.3631

Source of fuel consumption rate

:Predicting Ship Fuel Consumption: Update p18(Naval Post Graduate School)

The rates for 6, 8, 11, 13, 15, 17,19, 22, 24, 26, 28, and 30 knots are the mean values.

APPENDIX D
(ASSOCIATED COST OF CG)

Appendix E provides and explanation of each cell on page three.

```
Cell A5: +A:B21
Cell D2: +A:B8
Cell D3: +A:B12
Cell D4: @INDEX(A:J2..A;O5,A:B3,A:B8)
Cell D5: +D4/D3
Cell D6: +D5/24
Cell D7: @VLOOKUP(D3,H2..I27,1)
Cell D8: +D5*D7*2
Cell D9: +D8*700
Cell D10:+A:B18*7-D6*2
Cell D11:@IF(D4=0,0,D10*24*I3*700)
Cell D12:@INT(A:B15*7/D10+.9999)
Cell D13:(D9*D12+D11*A:B15*7/D10)*A5/1,000,000
Cell D14:@IF(D4=0,A5,(@INT((A:B18*7*1.5/D10)+.9999))*A5)

Cell E2: +A:B9
Cell E3: +A:B13
Cell E4: @INDEX(A:J2..A;O5,A:B3,A:B9)
Cell E5: +E4/E3
Cell E6: +E5/24
Cell E7: @VLOOKUP(E3,H2..I27,1)
Cell E8: +E5*E7*2
Cell E9: +E8*700
Cell E10:+A:B18*7-E6*2
Cell E11:@IF(E4=0,0,E10*24*I3*700)
Cell E12:@INT(A:B16*7/E10+.9999)
Cell E13:(E9*E12+E11*A:B16*7/E10)*A5/1,000,000
Cell E14:@IF(E4=0,A5(@INT((A:B18*7*1.5/E10)+.9999))*A5)

Cell F13:(D13-E13)
Cell F14:(D14-E14)*1,024.9
```

The calculation of CG asset cost in 1997's dollar.
The unit cost of last CG-47 was 820.1 million dollar in 1988.
Source:U.S.WEAPON SYSTEMS COSTS,90(DATA SEARCH ASSOCIATES)

The deflator of military procurement in 1988 is 0.8002.
Source:NATIONAL DEFENCE BUDGET ESTIMATES-FY1997 p42(U.S.Secretary of Defense)

820.1/0.8002=**1,024.9**

```
Cell H3:6,   Cell I3:0.8044
Cell H4:7,   Cell I4:0.815
Cell H5:8,   Cell I5:0.8293
Cell H6:9,   Cell I6:0.8477
Cell H7:10,  Cell I7:0.871
Cell H8:11,  Cell I8:0.8997
Cell H9:12,  Cell I9:0.9346
Cell H10:13, Cell I10:0.9765
Cell H11:14, Cell I11:1.0263
Cell H12:15, Cell I12:1.0851
Cell H13:16, Cell I13:1.154
Cell H14:17, Cell I14:1.2343
Cell H15:18, Cell I15:1.3276
Cell H16:19, Cell I16:1.4358
Cell H17:20, Cell I17:1.561
Cell H18:21, Cell I18:1.7051
Cell H19:22, Cell I19:1.873
Cell H20:23, Cell I20:2.0665
Cell H21:24, Cell I21:2.2905
Cell H22:25, Cell I22:2.5502
Cell H23:26, Cell I23:2.8521
Cell H24:27, Cell I24:3.204
Cell H25:28, Cell I25:3.6152
Cell H26:29, Cell I26:4.0977
Cell H27:30, Cell I27:4.666
```

Source of fuel consumption rate
:Predicting Ship Fuel Consumption: Update p20 (Naval Post Graduate School)

APPENDIX E
(ASSOCIATED COST OF DDG)

Appendix E provides and explanation of each cell on page four.

```
Cell A5: +A:B21
Cell D2: +A:B8
Cell D3: +A:B12
Cell D4: @INDEX(A:J2..A;O5,A:B3,A:B8)
Cell D5: +D4/D3
Cell D6: +D5/24
Cell D7: @LOOKUP(D3,H2..I27,1)
Cell D8: +D5*D7*2
Cell D9: +D8*700
Cell D10:+A:B18*7-D6*2
Cell D11:@IF(D4=0,0,D10*24*I3*700)
Cell D12:+A:B15*7/D10
Cell D13:+(D9+D11)*D12*A5
Cell D14:@INT((A:B18*7*1.5/D10)+.9999)*A5

Cell E2: +A:B9
Cell E3: +A:B13
Cell E4: @INDEX(A:J2..A;O5,A:B3,A:B9)
Cell E5: +E4/E3
Cell E6: +E5/24
Cell E7: @LOOKUP(E3,H2..I27,1)
Cell E8: +E5*E7*2
Cell E9: +E8*700
Cell E10:+A:B18*7-E6*2
Cell E11:@IF(E4=0,0,E10*24*I3*700)
Cell E12:+A:B15*7/E10
Cell E13:+(E9+E11)*E12*A5
Cell E14:@INT((A:B18*7*1.5/E10)+.9999)*A5

Cell F13:(D13-E13)/1,000,000
Cell F14:(D14-E14)*829.8
```

The calculation of DDG asset cost in 1997's dollar.
The unit cost of last DDG51 was 829.8 billion dollar in 1997.
Source:U.S.WEAPON SYSTEMS COSTS,96(DATA SEARCH ASSOCIATES)

```
Cell H3:6,   Cell i3:0.6307
Cell H4:7,   Cell I4:0.6398
Cell H5:8,   Cell I5:0.6521
Cell H6:9,   Cell I6:0.6681
Cell H7:10,  Cell I7:0.6882
Cell H8:11,  Cell I8:0.7133
Cell H9:12,  Cell I9:0.7438
```

Cell H10:13, Cell I10:0.7808
Cell H11:14, Cell I11:0.825
Cell H12:15, Cell I12:0.8776
Cell H13:16, Cell I13:0.9398
Cell H14:17, Cell I14:1.0132
Cell H15:18, Cell I15:1.0995
Cell H16:19, Cell I16:1.2009
Cell H17:20, Cell I17:1.3201
Cell H18:21, Cell I18:1.4602
Cell H19:22, Cell I19:1.6253
Cell H20:23, Cell I20:1.8021
Cell H21:24, Cell I21:2.0507
Cell H22:25, Cell I22:2.3249
Cell H23:26, Cell I23:2.652
Cell H24:27, Cell I24:3.0443
Cell H25:28, Cell I25:3.5173
Cell H26:29, Cell I26:4.091
Cell H27:30, Cell I27:4.7912

Source of fuel consumption rate
:Predicting Ship Fuel Consumption: Update p22 (Naval Post Graduate School)

APPENDIX F
(ASSOCIATED COST OF DD)

Appendix F provides and explanation of each cell on page five.

```
Cell A5: +A:B23
Cell D2: +A:B8
Cell D3: +A:B12
Cell D4: @INDEX(A:J2..A;O5,A:B3,A:B8)
Cell D5: +D4/D3
Cell D6: +D5/24
Cell D7: @VLOOKUP(D3,H2..I27,1)
Cell D8: +D5*D7*2
Cell D9: +D8*700
Cell D10:+A:B18*7-D6*2
Cell D11:@IF(D4=0,0,D10*24*I3*700)
Cell D12:@INT(A:B15*7/D10+.9999)
Cell D13:(D9*D12+D11*A:B15*7/D10)*A5/1,000,000
Cell D14:@IF(D4=0,A5,(@INT((A:B18*7*1.5/D10)+.9999))*A5)

Cell E2: +A:B9
Cell E3: +A:B13
Cell E4: @INDEX(A:J2..A;O5,A:B3,A:B9)
Cell E5: +E4/E3
Cell E6: +E5/24
Cell E7: @VLOOKUP(E3,H2..I27,1)
Cell E8: +E5*E7*2
Cell E9: +E8*700
Cell E10:+A:B18*7-E6*2
Cell E11:@IF(E4=0,0,E10*24*I3*700)
Cell E12:@INT(A:B16*7/E10+.9999)
Cell E13:(E9*E12+E11*A:B16*7/E10)*A5/1,000,000
Cell E14:@IF(E4=0,A5(@INT((A:B18*7*1.5/E10)+.9999))*A5)

Cell F13:(D13-E13)
Cell F14:(D14-E14)*187.7
```

The calculation of DD asset cost in 1997's dollar.
The unit cost of last DD-963 was 65.7 million dollar in 1975.
Source:U.S.WEAPON SYSTEMS COSTS,77(DATA SEARCH ASSOCIATES)

The deflator of military procurement in 1975 is 0.3501.
Source:NATIONAL DEFENCE BUDGET ESTIMATES-FY1997 p42(U.S.Secretary of Defense)

65.7/0.3501=**187.7**

Cell H3:6, Cell I3:1.3032
Cell H4:7, Cell I4:1.3139

```
Cell H5:8,   Cell I5:1.3283
Cell H6:9,   Cell I6:1.3468
Cell H7:10,  Cell I7:1.3700
Cell H8:11,  Cell I8:1.3987
Cell H9:12,  Cell I9:1.4334
Cell H10:13, Cell I10:1.4749
Cell H11:14, Cell I11:1.5239
Cell H12:15, Cell I12:1.5814
Cell H13:16, Cell I13:1.6483
Cell H14:17, Cell I14:1.7257
Cell H15:18, Cell I15:1.8146
Cell H16:19, Cell I16:1.9170
Cell H17:20, Cell I17:2.0340
Cell H18:21, Cell I18:2.1676
Cell H19:22, Cell I19:2.3199
Cell H20:23, Cell I20:2.4933
Cell H21:24, Cell I21:2.6909
Cell H22:25, Cell I22:2.9158
Cell H23:26, Cell I23:3.1723
Cell H24:27, Cell I24:3.4648
Cell H25:28, Cell I25:3.7991
Cell H26:29, Cell I26:4.1818
Cell H27:30, Cell I27:4.6208
```

Source of fuel consumption rate
:Predicting Ship Fuel Consumption: Update p24 (Naval Post Graduate School)

APPENDIX G
(ASSOCIATED COST OF FFG)

Appendix G provides and explanation of each cell on page six.

```
Cell A5: +A:B24
Cell D2: +A:B8
Cell D3: +A:B12
Cell D4: @INDEX(A:J2..A;O5,A:B3,A:B8)
Cell D5: +D4/D3
Cell D6: +D5/24
Cell D7: @VLOOKUP(D3,H2..I27,1)
Cell D8: +D5*D7*2
Cell D9: +D8*700
Cell D10:+A:B18*7-D6*2
Cell D11:@IF(D4=0,0,D10*24*I3*700)
Cell D12:@INT(A:B15*7/D10+.9999)
Cell D13:(D9*D12+D11*A:B15*7/D10)*A5/1,000,000
Cell D14:@IF(D4=0,A5,(@INT((A:B18*7*1.5/D10)+.9999))*A5)

Cell E2: +A:B9
Cell E3: +A:B13
Cell E4: @INDEX(A:J2..A;O5,A:B3,A:B9)
Cell E5: +E4/E3
Cell E6: +E5/24
Cell E7: @VLOOKUP(E3,H2..I27,1)
Cell E8: +E5*E7*2
Cell E9: +E8*700
Cell E10:+A:B18*7-E6*2
Cell E11:@IF(E4=0,0,E10*24*I3*700)
Cell E12:@INT(A:B16*7/E10+.9999)
Cell E13:(E9*E12+E11*A:B16*7/E10)*A5/1,000,000
Cell E14:@IF(E4=0,A5(@INT((A:B18*7*1.5/E10)+.9999))*A5)

Cell F13:(D13-E13)
Cell F14:(D14-E14)*480.6
```

The calculation of FFG asset cost in 1997's dollar.
The unit cost of last FFG-7 was 336.3 million dollar in 1984.
Source:U.S.WEAPON SYSTEMS COSTS,88(DATA SEARCH ASSOCIATES)

The deflator of military procurement in 1984 is 0.6996.
Source:NATIONAL DEFENCE BUDGET ESTIMATES-FY1997 p42(U.S.Secretary of Defense)

336.6/0.6996=**480.6**

Cell H3:6, Cell I3:0.4161
Cell H4:7, Cell I4:0.4225

Cell H5:8,   Cell I5:0.4310
Cell H6:9,   Cell I6:0.4421
Cell H7:10,   Cell I7:0.4561
Cell H8:11,   Cell I8:0.4734
Cell H9:12,   Cell I9:0.4946
Cell H10:13, Cell I10:0.5202
Cell H11:14, Cell I11:0.5509
Cell H12:15, Cell I12:0.5874
Cell H13:16, Cell I13:0.6306
Cell H14:17, Cell I14:0.6816
Cell H15:18, Cell I15:0.7415
Cell H16:19, Cell I16:0.8119
Cell H17:20, Cell I17:0.8947
Cell H18:21, Cell I18:0.9921
Cell H19:22, Cell I19:1.1069
Cell H20:23, Cell I20:1.2424
Cell H21:24, Cell I21:1.4209
Cell H22:25, Cell I22:1.5938
Cell H23:26, Cell I23:1.8217
Cell H24:27, Cell I24:2.0952
Cell H25:28, Cell I25:2.4251
Cell H26:29, Cell I26:2.8255
Cell H27:30, Cell I27:3.3146

Source of fuel consumption rate
:Predicting Ship Fuel Consumption: Update p26 (Naval Post Graduate School)

APPENDIX H
(ASSOCIATED COST OF AOE)

Appendix H provides and explanation of each cell on page seven.

```
Cell A5: +A:B25
Cell D2: +A:B8
Cell D3: +A:B12
Cell D4: @INDEX(A:J2..A;O5,A:B3,A:B8)
Cell D5: +D4/D3
Cell D6: +D5/24
Cell D7: @VLOOKUP(D3,H2..I27,1)
Cell D8: +D5*D7*2
Cell D9: +D8*700
Cell D12:@INT(A:B15/4+.9999)
Cell D13:+D9*D12*A5/1,000,000
Cell D14:@IF(D4=0,A5,(@INT(D6/7*2*1.5/4+.9999)*A5))

Cell E2: +A:B9
Cell E3: +A:B13
Cell E4: @INDEX(A:J2..A;O5,A:B3,A:B9)
Cell E5: +E4/E3
Cell E6: +E5/24
Cell E7: @VLOOKUP(E3,H2..I27,1)
Cell E8: +E5*E7*2
Cell E9: +E8*700
Cell E12:@INT(A:B16/4+.9999)
Cell E13:+E9*E12*A5/1,000,000
Cell E14:@IF(E4=0,A5(@INT(E6/7*2*1.5/4+.9999)*A5))

Cell F13:(D13-E13)
Cell F14:(D14-E14)*324.3
```

The calculation of AOE asset cost in 1997's dollar.

The unit cost of last AOE-6 was 298.1 million dollar in 1993.
Source:U.S.WEAPON SYSTEMS COSTS,96(DATA SEARCH ASSOCIATES)

The deflator of military procurement in 1993 is 0.9191.
Source:NATIONAL DEFENCE BUDGET ESTIMATES-FY1997 p42(U.S.Secretary of Defense)

298.1/0.9191=**324.3**

```
Cell H3:6,    Cell I3:0.0015
Cell H4:7,    Cell I4:0.0030
Cell H5:8,    Cell I5:0.0045
Cell H6:9,    Cell I6:0.1126
Cell H7:10,   Cell I7:0.1962
```

Cell H8:11, Cell I8:0.2976
Cell H9:12, Cell I9:0.4179
Cell H10:13, Cell I10:0.5692
Cell H11:14, Cell I11:0.7205
Cell H12:15, Cell I12:0.9044
Cell H13:16, Cell I13:1.1224
Cell H14:17, Cell I14:1.3404
Cell H15:18, Cell I15:1.5928
Cell H16:19, Cell I16:1.8789
Cell H17:20, Cell I17:2.1650
Cell H18:21, Cell I18:2.4834
Cell H19:22, Cell I19:2.8219
Cell H20:23, Cell I20:3.1789
Cell H21:24, Cell I21:3.5602
Cell H22:25, Cell I22:3.9415
Cell H23:26, Cell I23:4.3426
Cell H24:27, Cell I24:4.7545
Cell H25:28, Cell I25:5.1732
Cell H26:29, Cell I26:5.5964
Cell H27:30, Cell I27:6.0199

Source of fuel consumption rate
:Predicting Ship Fuel Consumption: Update p48 (Naval Post Graduate School)
(The rate 6, 7, 13, 16, 19, 24, 27, 28, 29 knots are the mean value.)

LIST OF REFERENCES

1. U.S. Defense Mapping Agency, " Distances between ports", 1985.

2. Schrady, D.A., Smyth, G.K., Vassian, R.B., "Predicting Ship Fuel Consumption: Update", Naval PostGraduate School, Monterey, CA, July 1996.

3. Office of the under Secretary of Defense, "National Defense Budget Estimates-FY1997", April 1996.

4. Data Search Associates, " U.S. Weapon Systems Costs,90",1990.

5 Department Of Defense Appropriations for 1961.

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